ON THE EXPANSION OF THE UNIVERSE

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Abstract.
It is accepted from the beginning that nothing can escape from the Universe and a distance is found at which the expansion and compression of the space around a mass are in equilibrium. With this in mind the density of the space is calculated. The value obtained matches the value obtained experimentally by measuring cosmologic redshifts. Applying this concept to the mass of the Universe a second equation is found. This equation, together with the first one, allows the age of the Universe to be calculated and a value is found which is between the normally accepted limits. The same equations allow the deduction of the density equation calculated by Milne and the relativistic equation deduced by Friedmann. Finally, with these equations, the relation between the mass of the Universe, the speed of light and the universal constant of gravitation is found. This relation indicates possibly new areas of investigation.

Intoduction.

This work is based on simple concepts of physics and on Newtonian theory. It is confirmed by the results obtained, for example, for the density of empty space which value is in accordance with experimental value, the age of the Universe which is between the actually accepted limits, and the deduction of the density equation which is equivalent to deductions made by Milne and Friedmann.

Also, the present work establishes a relation between the mass of the Universe, the speed of Light(c) and the universal constant of gravitation (G). Other cosmologies (Newtonian or relativistic) do not establish any such relation. Both admit the mass of the Universe as a constant, so the relation obtained considers that the mass of Universe might not be necessarly a constant.

DEVELOPMENT.

I. Philosophical Concept.

The Universe is everything that exists. Therefore, nothing can escape from it. Calculations appear to confirm this hypothesis.

The escape speed for a body with mass *M* is given by

$$v_{esc}^2 = \frac{2GM}{R} \text{ , where } R \text{ is the radius of the body.} \tag{1.1}$$

For a mass *M* equal to the estimated mass of the Universe (M_U) and a radius *R* equal to the estimated radius of the Universe (R_U) the speed of escape is equal to *c* (speed of light), which seems to imply that nothing can escape from the Universe.

Then we can write the equation

$$R_U = \frac{2GM_U}{c^2} \tag{1.2}$$

II. **Distance of Meneses.**

Someone suggested this should be named the Distance of Meneses, to avoid confusion. What is it?

Suppose a mass *m* is attracted by the mass *M*. Then the force of attraction is:

$$F = G\frac{Mm}{R^2} \tag{2.1}$$

The expansion of the Universe is a part of the system, so it must not be disregarded. Therefore, both masses will tend to become increasingly distant from each other due to the effect of the expansion of the Universe, without the actual need for a force. If nothing else is considered, their speed relative to space remains zero. But, if this movement is in any way prevented, then a reaction force will appear, which may be calculated by Hubble's law, $v = H_0 R$

So the acceleration j of the expantion is:

$$j = \frac{dv}{dt} = \frac{dv}{dR} \times \frac{dR}{dt} = \frac{dv}{dR} \times v =$$
$$= H_0 \times H_0 R = H_o^2 R \tag{2.2}$$

Then, by the fundamental principle of dynamics, we have

$$F = mj = mH_0^2 R \tag{2.3}$$

Therefore, the body *m* is actually acted upon by two forces, one attractive and the other a force of repulsion.

One of the forces decreases with distance, while the other increases with distance. So there must be a distance at which they are equal, which is referred to here as the Distance of Meneses. Then

$$G\frac{Mm}{R^2} = mH_0^2 R$$

and so,

$$M = \frac{H_0^2}{G} \times R^3 \tag{2.4}$$

Assuming isotropy we will write

$$H_0^2 = \frac{4\pi}{3} \times H_0'^2 \tag{2.5}$$

then

$$M = \frac{4\pi}{3} \times H_0'^2 \frac{R^3}{G} \tag{2.6}$$

(where R =Distance of Meneses and $\frac{4\pi}{3}R^3$ is a volume of space.)

Therefore, $\frac{H_0'^2}{G}$ represents the density of empty space. Using values, and by calculation we get;

$$\rho_0 = 0,76408 \times 10^{-29}\, g / cm^3 \quad , \tag{2.7}$$

and this value matches the experimental value (see reference 4)

As previously shown, the Distance of Meneses is the distance where the forces of attraction and repulsion are equal, which is to say the distance at which the contraction equals the expansion.

Calculating that distance for the estimated mass of the Universe the estimated radius of the Universe is obtained. So we establish the following equation:

$$M_U = \frac{4\pi}{3}\frac{H_0'^2}{G}R_U^3 \tag{2.8}$$

III. Age of the Universe and change of the Hubble constant over time

If we eliminate M_U from equations (1.2) and (2.8) we get:

$$M_U = \frac{R_U c^2}{2G}$$

$$R_U^3 = \frac{M_U G}{H_0'^2} \times \frac{3}{4\pi}$$

$$R_U^3 = \frac{R_U c^2}{2G}\frac{G}{H_0'^2}\frac{3}{4\pi} \therefore R_U^2 = \frac{c^2}{H_0'^2}\frac{3}{8\pi} \therefore$$

$$\therefore \frac{R_U}{c} = \frac{1}{\sqrt{\frac{8\pi}{3} \times H_0'}} = I_U \text{ (age of Universe)} \tag{3.1}$$

Whit the accepted value of $H_0' = 0,714 \times 10^{-18}$ we get

$I_U = 15343,9 \times 10^6$ years (Ref. 2)

$$H_0' = \frac{1}{\sqrt{\frac{8\pi}{3}} \times t} \quad (3.2)$$

IV. Change of the mass of the Universe.

By eliminating of R_U from equations (1.2) and (2.8)

$$M_U = \frac{4\pi}{3}\frac{H_0'^2}{G} \times R_U^3 \qquad R_U = \frac{2GM_U}{c^2}$$

$$M_U = \frac{4\pi}{3}\frac{H_0'^2}{G}\left(\frac{2GM_U}{c^2}\right)^3 = \frac{4\pi H_0'^2}{G} \times \frac{8G^3M_U^3}{c^6}$$

Then

$$\frac{8G^3M_U}{c^6} = \frac{3}{4\pi} \times \frac{G}{H_0'^2}$$

$$\therefore M_U^2 = \frac{3}{32\pi} \times \frac{c^6}{G^2 H_0'^2} \quad \therefore M_U = \frac{\sqrt{3}c^3}{\sqrt{32\pi} \times H'G} \quad (4.1)$$

So, substituting H_0' by its changing value over time,(3.2)

$$M_U = \frac{\sqrt{3}c^3}{\sqrt{32\pi} \times G}\sqrt{\frac{8\pi}{3}} \times t = \frac{c^3}{2G}t$$

(4.2)

which is a new result.

V. Density.

Dividing M_U by the volume of the Universe we get :

$$\rho = \frac{M_U}{\frac{4\pi}{3}R_U^3} = \frac{M_U}{\frac{4\pi}{3}(ct)^3} = \frac{c^3 t}{2G} \times \frac{1}{\frac{4\pi}{3}c^3t^3} = \frac{3}{8\pi G t^2} \therefore$$

$$\therefore \frac{1}{t^2} = \rho\frac{8\pi G}{3} \qquad \therefore \left(\frac{v}{R}\right)^2 = \rho\frac{8\pi G}{3} \quad (5.1)$$

whereby, $v_t^2 = \rho\frac{8\pi}{3}R^2$ which means that

$$\left(\frac{dR}{dt}\right)^2 = \frac{8\pi G}{3} \times \rho \times R^2 \quad (5.2)$$

This equation is the equation deduced by Milne which is similar to that deduced by Friedmann (see references 5 and6)

CONCLUSION.

The conclusion that $M_U = \frac{c^3}{2G} \times t$ appears to be new but, because the equilibrium distance depends on M_U and thus on values of c and G, it seems to make sense. Therefore, it may be concluded that the Universe will expand, contract or be static depending on the values that c and G assume over time.

Values used in calculations.

$c = 2{,}998 \times 10^{10}\, cm/s$

$G = 6{,}672 \times 10^{-8}$

$H_0 = 1{,}4613105 \times 18^{-18} = \sqrt{\frac{4\pi}{3}} H_0' = \sqrt{\frac{4\pi}{3}} \times 0{,}714 \times 10^{-18}$

$R_U = 15325 \times 10^6\, ly(estim.\ rad.Univ.)$

$M_U = 0{,}977 \times 10^{56}\, g(estim.\ mass\ Univ.)$

$ly = 9{,}465 \times 10^{17}\, cm(ligth\ year)$

$\delta_U = 0{,}0764262 \times 10^{-28}\, g/cm^3 (actual\ med.\ dens.Univ.$

(All values are in cgs units).

References.:

1.CosmologicConstant(TheactualdensityofUniverse-www.fis.ufba.br/dfg/pice/ff/ff-07.htm)
2- J.Dunning- Davies;2006, Galilean Electrodynamics, **17**, 57
http://uk.arXiv.org astro-ph/0402554
3-.Friedmann equations-site http://en.wikipedia.org/wiki/Friedmann_equations

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